Arthritis & Rheumatism (Arthritis Care & Research)
Vol. 61, No. 4, April 15, 2009, 468–475
DOI 10.1002/art.24429

ORIGINAL ARTICLE

The Incidence of Primary Hip Osteoarthritis in Active Duty US Military Servicemembers

DANIELLE L. SCHER,[1] PHILIP J. BELMONT, JR.,[1] SALLY MOUNTCASTLE,[2] AND BRETT D. OWENS[1]

Objective. **Although multiple studies have reported the prevalence of primary hip osteoarthritis (OA), little has been reported on incidence rates of hip OA. We sought to determine the incidence rate and demographic risk factors of hip OA in an ethnically diverse and physically active population of US military servicemembers.**

Methods. **A query was performed using the US Defense Medical Epidemiology Database for the International Classification of Diseases, Ninth Revision, Clinical Modification code for hip OA (715.95). Multivariate Poisson regression analysis was used to estimate the rate of hip OA per 100,000 person-years, controlling for sex, race, age, rank, and service.**

Results. **The overall unadjusted incidence rate of hip OA was 35 per 100,000 person-years. Women, compared with men, had a significantly increased adjusted incidence rate ratio for hip OA of 1.87 (95% confidence interval [95% CI] 1.73–2.01). The adjusted incidence rate ratio for black servicemembers when compared with white servicemembers was 1.32 (95% CI 1.23–1.41). The adjusted incidence rate ratio for the ≥40-year-old age group compared with the 20-year-old group was 22.21 (95% CI 17.54–28.14). With junior officers as the referent category, junior enlisted, senior enlisted, and senior officers rank groups had a significantly increased adjusted incidence rate ratio for hip OA. With the Air Force as the referent category, each service had a significantly increased adjusted incidence rate ratio for hip OA.**

Conclusion. **Female sex; black race; age ≥40 years; junior enlisted, senior enlisted, and senior officer rank groups; and military service in the Navy, Army, or Marines were all risk factors for hip OA.**

INTRODUCTION

Osteoarthritis (OA) is a progressive disease caused by destruction of articular cartilage and proliferation and remodeling of subchondral bone. Symptomatic OA is a clinical diagnosis based on pain in the presence of particular radiographic features: osteophytes, joint space narrowing, subchondral sclerosis, and cysts. It is estimated that OA affects 27 million Americans (1), accounting for 55% of all arthritis-related hospitalizations (2). OA has been found to have average direct yearly costs between $2,650 and $5,700 per person (3,4). More than half of the societal costs of OA are lost productive work time, which has been estimated at $7.1 billion (5,6).

Primary hip OA is defined as hip OA in which there is no preexisting anatomic abnormality or disease process. Previous large-scale studies have found the prevalence of radiographic hip OA in US men and women older than 55 years to vary by nearly a factor of 10, between a low prevalence of 2.7%, reported in the first National Health and Nutrition Examination Survey, up to a high prevalence of 25.1%, reported in the Johnston County Osteoarthritis Project (7,8). Despite the variance in prevalence in these studies, European studies have shown that the prevalence of radiographic hip OA has remained constant throughout the past 4 decades within an urban population (9).

The majority of studies describing the frequency of hip OA have been prevalence studies. Previous studies have suggested that patients with OA have higher mortality rates than patients without OA (10,11). It may be hypothesized that this increase in mortality in patients with symptomatic hip OA may be attributable to its correlation with obesity (12–15) or to the secondary functional and physical limitations that can exacerbate other chronic medical comorbidities, such as hypertension and cardiovascular disease. Incidence rather than prevalence studies of hip OA are unaffected by the difference in mortality rates, and incidence was therefore determined to be a more

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army or the Department of Defense. All authors are employees of the United States government, and this work was prepared as part of their official duties.

[1]CPT Danielle L. Scher, MD, LTC Philip J. Belmont, Jr., MD, MAJ Brett D. Owens, MD: William Beaumont Army Medical Center, El Paso, Texas; [2]Sally Mountcastle, PhD: University of Texas, El Paso.

Address correspondence to CPT Danielle L. Scher, MD, Orthopaedic Surgery Department, William Beaumont Army Medical Center, 5005 North Piedras Street, El Paso, TX 79920. E-mail: Danielle.scher@amedd.army.mil.

Submitted for publication August 6, 2008; accepted in revised form January 7, 2009.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
APR 2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
The Incidence of Primary Hip Osteoarthritis in Active Duty US Military Servicemembers	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **William Beaumont Army Medical Center,Orthopaedic Surgery Department,5005 North Piedras Street,El Paso,TX,79920**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**8**	

appropriate tool to study the demographic risk factors, such as sex and race.

Calculating the incidence rate of hip OA is challenging because of the difficulty in defining the point of disease onset. The incidence of hip OA can also be difficult to quantify because the structural changes of the disease occur in most people as they get older, but these changes may not be accompanied by symptoms that warrant medical attention (14). Furthermore, these incidence rates may vary, depending on whether only moderate and severe radiographic changes are studied or whether mild changes are also included.

To better understand the population-based epidemiologic characteristics of hip OA, numerous studies have sought to determine the risk factors for this disease. In particular, prevalence with respect to sex, race, age, and activity level has been extensively studied, but only 2 studies have described incidence rates for hip OA (16,17). The incidence rates and epidemiologic variables in US Armed Forces servicemembers have not been reported (7) and are the subject of this study.

MATERIALS AND METHODS

The US Armed Forces represents a physically active population of male and female servicemembers with generally high occupational demands. These servicemembers participate in organized physical fitness training programs, and they must meet the standards of their individual service's physical fitness test and height/weight requirements semiannually. At the initial military entry examination, preexisting hip conditions are screened by history and physical examination. If there are any concerns about a preexisting hip condition, radiographs and an orthopedic consultation are obtained. Findings of any preexisting physical abnormalities, including potential causes of secondary hip OA such as developmental dysplasia of the hip, Legg-Calvé-Perthes disease, slipped capital femoral epiphysis, hip dislocation within 2 years preceding examination, or chronic OA excludes those individuals from initial entry into active duty military service.

The military maintains large medical databases, making it an excellent population in which to study musculoskeletal disorders such as hip OA. One such database is the Defense Medical Epidemiology Database (DMED), which compiles International Classification of Diseases, Ninth Revision (ICD-9) coding information for every patient encounter in a military treatment facility. This database also maintains the total number of servicemembers on active duty each year and contains patient demographic and military-specific data. The DMED is a frequently updated database that is able to track military servicemembers as they move throughout the world. The DMED also adjusts for servicemembers as they retire and as they enlist into the Armed Forces. It has been used previously to provide information on various musculoskeletal conditions (18,19).

The DMED provides 4 types of data: demographic features, inpatient hospitalizations, ambulatory visits, and reportable events. The outpatient data in the DMED is a combination of the standard ambulatory data records extracted from the Ambulatory Data System, from the Composite Health Care System used in military treatment facilities worldwide, and from outsourced (nonmilitary) outpatient health care facilities providing care to active-duty servicemembers.

To determine the total number of patients with hip OA, we queried the ambulatory DMED system for the years 1998–2006 using the ICD-9 Clinical Modification code 715.95. We chose to include only outpatient data because hip OA is primarily an outpatient diagnosis, and the small numbers from inpatient data would not have been significant. Additionally, inpatient data is less likely to represent first time diagnosis, and its inclusion could lead to multiple counting of primary hip OA. Ambulatory encounters were limited to a first occurrence to exclude repeat coding of the same initial diagnosis for all services during the study period. We then categorized the results by sex, race, age, rank, and military service. Race data is routinely obtained from the Defense Manpower Data Center, which compiles servicemembers' self-report of race with the following options: white, black, Hispanic, Alaskan Native/American Indian, Asian/Pacific Islander, and other. The DMED classifies these categories into 3 larger groups: white, black, and other. Mixed-race individuals were classified according to self-report. The age categories used were $<$20 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, and $\geq$40 years. The rank categories used were junior enlisted (E1–E4), senior enlisted (E5–E9), junior officers (O1–O3), and senior officers (O4–O9). The military service categories used were Army, Navy, Air Force, and Marines. The DMED does not compile height or weight data on servicemembers and so this information was not available for analysis. The database was also queried for the total number of servicemembers on active duty during the study time period, and the results were categorized by sex, race, age, rank, and service. To estimate incidence, 1 exposure year was defined as 1 year that the servicemember was in the US Armed Forces.

For incident OA, the outcome measure was the unadjusted incidence rate per 100,000 person-years. We used multivariate Poisson regression to estimate the rate of hip OA per 100,000 person-years by sex, race, age, rank, and service (unadjusted rates). Additionally, using Poisson regression, we computed rate ratios for sex, using men as the referent, and controlling for differences in race, age, rank, and service between men and women (adjusted rates). Rate ratios were also calculated for race, using white as the referent category; age, using $<$20 years as the referent category; rank, using junior officers as the referent category; and service, using the Air Force as the referent category, all of which were adjusted for other covariates. All statistical analysis was performed using SAS software, version 9.1 (SAS, Cary, NC). This study received Institutional Review Board approval from William Beaumont Army Medical Center Department of Clinical Investigation Protocol.

Table 1. Unadjusted and adjusted incidence rates and adjusted incidence rate ratios of hip OA among members of the US military, 1998–2006, by age and sex*

	Women			Men			
Age group, years	Cases	Person-years	Unadjusted incidence rate†	Cases	Person-years	Unadjusted incidence rate†	Adjusted incidence rate (95% CI)‡
<20	48	174,654	27.5	50	825,973	6.05	5.61 (3.73–8.45)
20–24	164	638,889	25.7	317	3,328,162	9.52	3.20 (2.63–3.89)
25–29	138	376,651	36.6	396	2,097,713	18.9	1.94 (1.59–2.37)
30–34	137	218,219	62.8	381	1,571,007	24.3	2.59 (2.11–3.18)
35–39	162	189,031	85.7	748	1,451,678	51.5	1.53 (1.28–1.82)
≥40	296	151,654	195	1,425	1,076,371	132	1.42 (1.25–1.61)
Overall	945	1,749,098	54	3,317	10,350,904	32	1.87 (1.73–2.01)

* OA = osteoarthritis; 95% CI = 95% confidence interval.
† Per 100,000 person-years.
‡ Male is the referent category. Adjusted for age, service, rank, and race.

RESULTS

A total of 4,262 cases of hip OA were documented in our population at risk of 12,096,304 person-years. The overall incidence rate of hip OA in our population was 35 cases per 100,000 person-years. The unadjusted incidence rate of hip OA was 54 cases per 100,000 person-years among women and 32 cases per 100,000 person-years among men. Women, when compared with men, had a significantly increased adjusted incidence rate ratio for hip OA of 1.87 (95% confidence interval [95% CI] 1.73–2.01). When examining the sex/age subcategories, it was found that the adjusted incidence rate ratio for women, when compared with men, was statistically significant at all age subcategories. The incidence rates for men and women by age group are listed in Table 1.

The unadjusted incidence rate for hip OA per 100,000 person-years was 33 among whites, 51 among blacks, and 21 among others. Blacks, when compared with whites, had a significantly increased adjusted incidence rate ratio for hip OA of 1.32 (95% CI 1.23–1.41). When examining the racial age subcategories, it was found that the adjusted incidence rate ratio for blacks, when compared with whites, became statistically significant at the age subcategory of 25–29 years and each older subcategory thereafter. The incidence rates for race are presented in Table 2.

We found that older servicemembers had a higher incidence rate for hip OA when compared with younger servicemembers. The highest incidence rate was seen in the ≥40 years age group with an incidence rate of 140 per 100,000 person-years. The adjusted rate ratio for the ≥40 years age group compared with the <20 years age group was 22.21 (95% CI 17.54–28.14). A complete listing of the age data is shown in Table 3.

The unadjusted incidence rate for hip OA among the 4 rank groups was 16.6 for the junior enlisted group, 24.8 for junior officers, 46.4 for the senior enlisted group, and 112 for the senior officers per 100,000 person-years. When compared with the junior officers as the referent category, all of the other rank groups had increased adjusted incidence rate ratios for hip OA: junior enlisted group 1.90 (95% CI 1.63–2.22), senior enlisted group 1.31 (95% CI 1.16–1.48), and senior officers 1.50 (95% CI 1.31–1.73). The incidence rates for rank groups are presented in Table 4.

The unadjusted incidence rate for hip OA among the 4 services was 43.3 for the Army, 37.0 for the Navy, 26.8 for the Air Force, and 26.3 for the Marines per 100,000 person-years. Each service, when compared with the Air Force as the referent category, had a significantly increased adjusted incidence rate ratio for hip OA: Army 1.90 (95% CI 1.75–2.07), Navy 1.63 (95% CI 1.49–1.78), and Marines 1.85 (95% CI 1.64–2.09). We found that the adjusted incidence rate ratio for all services, when compared with the Air Force, was statistically significant at all the age subcategories. The incidence rates for service are presented in Table 5.

DISCUSSION

In this large-scale database study, we found that female sex; black race; age ≥40 years; junior enlisted, senior enlisted, and senior officer rank groups; and military service in the Navy, Army, or Marines were significant risk factors for the development of incident hip OA when compared with male sex, white race, age <40 years, junior enlisted rank group, and service in the Air Force. Incidence rates were determined for this unique population of individuals who are all active-duty US military servicemembers. These servicemembers are required to meet the physical induction standards of their service when joining the military, which excludes from service those individuals with certain preexisting medical conditions, e.g., potential causes of secondary hip OA such as developmental dysplasia of the hip, Legg-Calvé-Perthes disease, and slipped capital femoral epiphysis. If there are any concerns about a preexisting hip condition, radiographs and an orthopedic consultation are obtained prior to initial entry into active duty military service. Active-duty US military servicemembers continue to be physically active on a daily basis. Standard training for active-duty military servicemembers includes multiple weekly aerobic and strength-training sessions, daily physically demanding military occupational specialty training, overseas deployments,

Table 2. Unadjusted incidence rates and adjusted incidence rate ratios of hip OA among members of the US military, 1998–2006, by age and race*

Age group, years	Cases	Person-years	Unadjusted incidence rate†	Adjusted incidence rate ratio (95% CI)‡
<20				
Black	13	179,936	7.22	0.54 (0.30–0.97)
Other	16	105,841	15.1	0.95 (0.51–1.75)
White	73	716,482	10.2	N/A
20–24				
Black	88	722,485	12.2	0.76 (0.60–0.97)
Other	43	425,248	10.1	0.74 (0.54–1.02)
White	350	2,819,318	12.4	N/A
25–29				
Black	180	500,449	36.0	1.57 (1.30–1.90)
Other	38	260,672	14.6	0.70 (0.50–0.99)
White	316	1,713,500	18.4	N/A
30–34				
Black	171	405,691	42.2	1.25 (1.02–1.52)
Other	39	164,522	23.7	0.80 (0.57–1.11)
White	308	1,219,013	25.3	N/A
35–39				
Black	330	375,482	87.9	1.57 (1.36–1.82)
Other	37	131,355	28.2	0.53 (0.38–0.74)
White	543	1,133,872	47.9	N/A
≥40				
Black	440	232,568	189	1.35 (1.20–1.52)
Other	82	102,032	80.4	0.60 (0.48–0.75)
White	1,199	893,425	134	N/A
Overall				
Black	1,222	2,416,611	50.6	1.32 (1.23–1.41)
Other	255	1,189,670	21.4	0.66 (0.58–0.75)
White	2,789	8,495,610	32.8	N/A

* OA = osteoarthritis; 95% CI = 95% confidence interval; N/A = not applicable because this category was used as referent.
† Per 100,000 person-years.
‡ White is the referent category. Adjusted for age, service, rank, and sex.

maintaining height/weight requirements, and passing a semiannual service-specific physical fitness test. A service member's inability to complete any of the aforementioned requirements could result in a medical or administrative discharge from the military.

Previous incidence studies of hip OA have reported an overall incidence rate between 56 and 88 cases per 100,000 person-years, with incidence rates for men of 47–69 cases and for women of 68–105 cases per 100,000 person-years (16,17). The incidence rate of hip OA in our population was 35 cases per 100,000 person-years, with 32 cases for men and 54 cases for women per 100,000 person-years. Our lower overall incidence rates are likely attributable to a younger and healthier population. As seen in Table 3, there was an incidence rate of 55 for those in the 35–39 years age category, with a jump to 140 in the ≥40 years age category per 100,000 person-years.

Table 3. Incidence rate and adjusted incidence rate ratio of hip OA among members of the US military, 1998–2006, by age*

Age group, years	Incidence rate†	Adjusted incidence rate ratio (95% CI)‡
<20	10	N/A
20–24	12	1.35 (1.09–1.68)
25–29	22	2.99 (2.39–3.75)
30–35	29	4.54 (3.58–5.75)
35–39	55	8.93 (7.05–11.31)
≥40	140	22.21 (17.54–28.14)

* See Table 2 for definitions.
† Per 100,000 person-years.
‡ Referent category was the <20 year age group. Adjusted for sex, service, rank, and race.

Our results found an overall increased risk in the development of hip OA in women compared with men, with an adjusted incidence rate ratio of 1.87 (95% CI 1.73–2.01). This finding is in accordance with the results of a meta-analysis performed by Srikanth et al (20). Analyzing 2 incidence studies of hip OA (16,17), both demonstrated a statistically significant reduction in the overall incidence rate of hip OA in men when compared with women (incidence rate ratio 0.64, 95% CI 0.48–0.86). Our study showed that at all individual age subcategories there was a significant increased adjusted incidence rate ratio when comparing women with men (Table 1). The uniform find-

Table 4. Unadjusted incidence rates and adjusted incidence rate ratios of hip OA among members of the US military, 1998–2006, by age and rank*

Age group, years	Cases	Person-years	Unadjusted incidence rate†	Adjusted incidence rate ratio (95% CI)‡
<20				
E1–E4	98	1,000,627	9.79	§
O1–O3	§	§	§	N/A
E5–E9	§	§	§	§
O4–O9	§	§	§	§
20–24				
E1–E4	433	3,315,825	13.1	2.64 (1.36–5.11)
O1–O3	9	170,631	5.27	N/A
E5–E9	39	480,595	8.11	1.58 (0.76–3.26)
O4–O9	§	§	§	§
25–29				
E1–E4	243	838,911	29	1.85 (1.38–2.47)
O1–O3	58	423,457	13.7	N/A
E5–E9	233	1,212,253	19.2	1.25 (0.93–1.67)
O4–O9	§	§	§	§
30–34				
E1–E4	76	171,963	44.2	1.47 (1.08–2.02)
O1–O3	86	354,549	24.3	N/A
E5–E9	338	1,189,308	28.4	1.17 (0.92–1.48)
O4–O9	18	73,406	24.5	1.05 (0.63–1.74)
35–39				
E1–E4	38	38,407	98.9	2.10 (1.40–3.14)
O1–O3	64	157,389	40.7	N/A
E5–E9	696	1,211,253	57.5	1.41 (1.09–1.83)
O4–O9	112	233,660	47.9	1.28 (0.94–1.74)
≥40				
E1–E4	5	3,645	137	1.20 (0.48–2.97)
O1–O3	75	69,746	108	N/A
E5–E9	916	695,032	132	1.29 (1.01–1.63)
O4–O9	725	459,602	158	1.58 (1.24–2.00)
Overall				
E1–E4	893	5,369,378	16.6	1.90 (1.63–2.22)
O1–O3	292	1,175,772	24.8	N/A
E5–E9	2,222	4,788,441	46.4	1.31 (1.16–1.48)
O4–O9	855	766,668	112	1.50 (1.31–1.73)

* E1–E4 = junior enlisted ranks; O1–O3 = junior officer ranks; E5–E9 = senior enlisted ranks; O4–O9 = senior officer ranks. See Table 2 for additional definitions.
† Per 100,000 person-years.
‡ E1–E4 is the referent category. Adjusted for age, service, race, and sex.
§ These age groups are not present in these rank categories.

ings of an increased incidence of hip OA in women in this and the previously mentioned incidence studies need to be evaluated with respect to previous prevalence studies of hip OA. Prior prevalence studies of hip OA have reported mixed results, including an increased prevalence in women (13,14,21,22) or a lack of a sex difference (8,9,15,20,23). Sex differences in incidence studies, as compared with prevalence studies, are likely to be more reliable because they are unaffected by the difference in mortality rates between men and women. The previous incidence studies of hip OA were performed among whites (16,17). In contrast, our study is the first to our knowledge to have discovered an increased incidence of hip OA among women in a racially diverse population.

Our results found an overall increased risk in the development of hip OA in black servicemembers compared with white servicemembers, with an adjusted incidence rate ratio of 1.32 (95% CI 1.23–1.41). Currently, there are no published studies comparing the incidence rate between these 2 races because epidemiologic studies have historically looked at only the prevalence of hip OA in diverse populations around the globe. Results of a small study of nearly 200 people from South Africa reported a hip OA prevalence rate of only 2% in their black population (24). A large-scale study of a rural population in North Carolina showed the prevalence of hip OA to be nearly equal between blacks and whites, with overall prevalences of 29.9% and 26.4%, respectively (8). We acknowledge that it is difficult to interpret the data for the racial servicemember category of other because it is made up of numerous ethnicities; however, after adjusting for the covariant risk factors, the other racial servicemember cate-

Table 5. Unadjusted incidence rates and adjusted incidence rate ratios of hip OA among members of the US military, 1998–2006, by age and service*

Age group, years	Cases	Person-years	Unadjusted incidence rate†	Adjusted incidence rate ratio (95% CI)‡
<20				
Army	42	343,328	12.2	8.90 (2.76–28.8)
Navy	30	253,519	11.8	8.58 (2.62–28.1)
Air Force	3	181,108	1.66	N/A
Marines	23	222,672	10.3	9.91 (2.95–33.3)
20–24				
Army	240	1,374,192	17.5	4.21 (3.03–5.85)
Navy	106	1,026,433	10.3	2.44 (1.70–3.49)
Air Force	42	865,173	4.85	N/A
Marines	93	701,253	13.3	3.61 (2.50–5.23)
25–29				
Army	222	917,370	24.2	2.84 (2.10–3.85)
Navy	209	664,843	31.4	3.92 (2.89–5.32)
Air Force	52	637,611	8.16	N/A
Marines	51	254,797	20	2.86 (1.94–4.22)
30–34				
Army	248	660,807	37.5	2.25 (1.74–2.91)
Navy	145	481,836	30.1	2.01 (1.52–2.65)
Air Force	81	503,475	16.1	N/A
Marines	44	143,108	30.7	2.22 (1.53–3.21)
35–39				
Army	370	532,540	69.5	1.63 (1.37–1.94)
Navy	257	464,310	55.4	1.42 (1.18–1.70)
Air Force	210	533,460	39.4	N/A
Marines	73	110,399	66.1	1.73 (1.33–2.27)
≥40				
Army	706	397,971	177	1.60 (1.42–1.81)
Navy	452	345,491	131	1.28 (1.12–1.45)
Air Force	451	412,313	109	N/A
Marines	112	72,250	155	1.46 (1.19–1.80)
Overall				
Army	1,828	4,226,208	43.3	1.90 (1.75–2.07)
Navy	1,199	3,236,432	37.0	1.63 (1.49–1.78)
Air Force	839	3,133,140	26.8	N/A
Marines	396	1,504,479	26.3	1.85 (1.64–2.09)

* See Table 2 for definitions.
† Per 100,000 person-years.
‡ Air Force is the referent category. Adjusted for age, rank, race, and sex.

gory did not have a significantly different incidence rate when compared with white servicemembers. Numerous studies of Asian populations have shown that the prevalence rate of primary hip OA is small, ranging from 0–2% in the Japanese, Chinese, and Taiwanese populations (25–29). This lower age-standardized prevalence of hip OA occurs in native Asian populations compared with the US white population (28) and has been shown to translate to Asians living within the US as well (30). The most common cause of hip OA in Asian populations has been found to be secondary hip OA, caused by acetabular dysplasia, rather than primary hip OA (25– 27,31).

As anticipated, our study demonstrated a statistically significant increased risk for the development of hip OA with increasing age. The adjusted incidence rate ratio was 22.21 (95% CI 17.54–28.14) for those servicemembers ≥40 years of age compared with those servicemembers <20 years of age. Cushnaghan and Dieppe have reported that the hip was the earliest joint affected by OA for both sexes (32). It is recognized that hip OA incidence rates increase with age (9,15–17). However, what is not clear is the extent to which activity level and occupational demands may impact the incidence.

There was a statistically significant increased risk for development of hip OA when examining the adjusted incidence rate ratio for servicemembers in the junior enlisted, senior enlisted, and senior officers rank groups when compared with the junior officers rank group. Compared with servicemembers in the Air Force, there was a statistically significant increased risk for development of hip OA when examining the adjusted incidence rate ratio for servicemembers in the Army, Navy, and Marines. In this database, rank group and military service act as a proxy for activity level. Therefore, these results emphasize the role of activity level, including occupational demands, in the development of hip OA. Those military service-

members in the junior enlisted rank group and those servicemembers in the Army, Navy, and Marines generally have an overall higher activity and occupational demand level than the referent groups. The lowest rank group, consisting of junior enlisted servicemembers, comprises the majority of combat and combat support units, maintains superior physical readiness through structured physical training programs, and is subject to the physical rigors of repeated combat deployments. For example, servicemembers in the Army and Marines serving as infantry often deploy for combat tours and routinely conduct combat operations carrying an average load of 70 pounds. This high level of physical activity is in accordance with our finding that the adjusted incidence rate ratio was highest in the junior enlisted rank group. Although their current duties may not be as physically demanding as the enlisted ranks, the senior officer rank group has the second highest adjusted incidence rate ratio. This may be attributable to the cumulative physical activity that they encounter during the years of service required to reach their current rank level.

Several studies that have examined former recreational and professional athletes have shown a positive correlation between various sports participation and an increased prevalence of hip OA (33–41). A retrospective case–control study of regular high-mileage, long-distance male runners who were longitudinally followed for 15 years found radiologic evidence of OA consisting of subchondral sclerosis (59%) and osteophyte formation (29%) in their cohort (39). Additionally, 30% of these runners at age 42 years had symptomatic hip pain, and their long-term, high-intensity, high-mileage running was found to be statistically equivalent to age as a risk factor for the development of radiographic hip OA and symptomatic hip pain. Prolonged exposure to higher levels of recreational physical activity has been reported to have a statistically significant increase in the risk of developing radiographic symptomatic hip OA in women and men ranging from a factor of 2 to 4.5, respectively (37,40,41). In contrast, several surveys have found no increased risk for the development of hip OA secondary to running or increased physical activity levels (42–45).

Similarly, the prevalence of radiographic hip OA has been reported to be statistically significantly increased for farmers (12,46,47) and for those with jobs involving heavy manual labor (48,49) compared with population controls, ranging from factors of 3.2–10 to 2.0, respectively. Military service is somewhat comparable to farming and heavy manual labor in that the occupational demands often require regular heavy lifting, prolonged standing, and walking over rough terrain. Both women and men who have been exposed to high physical demands either at work or during sports activities have been found to have a statistically significant increased risk for symptomatic primary hip OA of 4.3 (95% CI 1.1–11.0) and 8.5 (95% CI 4.0–17.9), respectively (41,50). Overall, the higher incidence rate of hip OA observed in military servicemembers in the ≥40 years age group in this study is attributable to their overall higher activity and occupational demand level compared with that of the general population. Moreover, within this military population it has been observed that lower rank servicemembers and those serving in the Army, Navy, and Marines will have higher incidence rates of hip OA, most likely due to their overall higher activity level and occupational demand.

The greatest strength of this study is the large number of active-duty servicemembers who were captured in the closed military health care system and annotated in the DMED. The authors acknowledge the limitations inherent to any large database study. First, multiple physicians evaluated and coded the patient encounters, which may decrease the accuracy of the diagnosis of hip OA. The DMED is also subject to the dynamic cohort of military servicemembers that is the subject of this study. Although the DMED cannot track individuals, the total number of persons used in our statistical analysis represents the population as a whole at risk for each calendar year. Second, most studies describing hip OA have focused on radiographic findings. In this study we are uncertain to what extent the diagnoses were determined by radiographic findings alone, clinical evidence of symptomatic hip OA, or a combination of the two. As the data is based upon patient-driven clinic visits, one can assume that the data is reflective of symptomatic complaints in the context of radiographic findings. Nonradiographic methods based on pain or other symptoms may result in the overdiagnosis of hip OA. Conversely, many patients with radiographic evidence of hip OA do not have symptoms and may not seek medical care, and thus would not be captured in a database study (14). It is symptomatic hip OA that causes pain, disability, and utilization of health care resources and therefore is the subject of this study. Third, our subjects were all active-duty servicemembers who maintain characteristics that may limit the ability to generalize these results. The results can be utilized, however, in comparison with populations of physically active individuals whose activity may be through sports or occupation. Further prospective studies would be helpful to better understand the effect of high activity levels and occupational demand on the development of hip OA within an ethnically diverse population.

AUTHOR CONTRIBUTIONS

Dr. Scher had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study design. Scher, Belmont, Owens.
Acquisition of data. Scher, Owens.
Analysis and interpretation of data. Scher, Belmont, Mountcastle, Owens.
Manuscript preparation. Scher, Belmont, Owens.
Statistical analysis. Scher, Belmont, Mountcastle, Owens.

REFERENCES

1. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al, for the National Arthritis Data Workgroup. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. Arthritis Rheum 2008;58:26–35.
2. Lethbridge-Cejku M, Helmick CG, Popovic JR. Hospitalizations for arthritis and other rheumatic conditions: data from the 1997 National Hospital Discharge Survey. Med Care 2003;41:1367–73.
3. Gabriel SE, Crowson CS, Campion ME, O'Fallon WM. Direct medical costs unique to people with arthritis. J Rheumatol 1997;24:719–25.

4. Maetzel A, Li LC, Pencharz J, Tomlinson G, Bombardier C, and the Community Hypertension and Arthritis Project Study Team. The economic burden associated with osteoarthritis, rheumatoid arthritis, and hypertension: a comparative study. Ann Rheum Dis 2004;63:395–401.
5. Felson DT, Zhang Y. An update on the epidemiology of knee and hip osteoarthritis with a view to prevention [review]. Arthritis Rheum 1998;41:1343–55.
6. Ricci JA, Stewart WF, Chee E, Leotta C, Foley K, Hochberg MC. Pain exacerbation as a major source of lost productive time in US workers with arthritis. Arthritis Rheum 2005;53:673–81.
7. Lawrence RC, Hochberg MC, Kelsey JL, McDuffie FC, Medsger TA, Felts WR, et al. Estimates of the prevalence of selected arthritic and musculoskeletal diseases in the United States. J Rheumatol 1989;16:427–41.
8. Jordan JM, Linder GF, Renner JB, Fryer JG. The impact of arthritis in rural populations. Arthritis Care Res 1995;8:242–50.
9. Danielsson L, Lindberg H. Prevalence of coxarthrosis in an urban population during four decades. Clin Orthop 1997;342: 106–10.
10. Monson RR, Hall AP. Mortality among arthritics. J Chronic Dis 1976;29:459–67.
11. Cerhan JR, Wallace RB, El-Khoury GY, Moore TD, Long CR. Decreased survival with increasing prevalence of full-body radiographically defined osteoarthritis in women. Am J Epidemiol 1995;141:225–34.
12. Croft P, Coggon D, Cruddas M, Cooper C. Osteoarthritis of the hip: an occupational disease in farmers. BMJ 1992;304:1269–72.
13. Heliovaara M, Makela M, Impivaara O, Knekt P, Aromma A, Sievers K. Association of overweight, trauma and workload with coxarthrosis: a health survey of 7,217 persons. Acta Orthop Scand 1993;64:513–8.
14. Odding E, Valkenburg HA, Algra D, Vandenouweland FA, Grobbee DE, Hofman A. Associations of radiological osteoarthritis of the hip and knee with locomotor disability in Rotterdam Study. Ann Rheum Dis 1998;57:203–8.
15. Tepper S, Hochber MC. Factors associated with hip osteoarthritis: data from the First National Health and Nutrition Examination Survey (NHANES-I). Am J Epidemiol 1993; 137:1081–8.
16. Oliveria SA, Felson DT, Reed JI, Cirillo PA, Walker AM. Incidence of symptomatic hand, hip, and knee osteoarthritis among patients in a health maintenance organization. Arthritis Rheum 1995;38:1134–41.
17. Wilson MG, Michet CJ Jr, Ilstrup DM, Meltion LJ 3rd. Idiopathic symptomatic osteoarthritis of the hip and knee: a population-based incidence study. Mayo Clinic Proc 1990;65:1214–21.
18. Owens B, Mountcastle S, White D. Racial differences in tendon rupture incidence. Int J Sports Med 2007;28:617–20.
19. Owens BD, Mountcastle SB, Dunn WR, DeBaradino TM, Taylor DC. Incidence of anterior cruciate ligament injury among active duty US military servicemen and servicewomen. Mil Med 2007;172:90–1.
20. Srikanth VK, Fryer JL, Zhai G, Winzenberg TM, Hosmer D, Jones G. A meta-analysis of sex differences prevalence, incidence and severity of osteoarthritis. Osteoarthritis Cartilage 2005;13:769–81.
21. Van Saase JL, van Romunde LK, Cats A, Vandenbroucke JP, Valkenburg HA. Epidemiology of osteoarthritis: Zoetermeer survey. Comparison of radiological osteoarthritis in a Dutch population with that in 10 other populations. Ann Rheum Dis 1989;48:271–80.
22. Joerring K. Osteoarthritis of the hip: epidemiology and clinical role. Acta Orthop Scand 1980;51:523–30.
23. Hirsch R, Fernandes RJ, Pillemer SR, Hochberg MC, Lane NE, Altman RD, et al. Hip osteoarthritis prevalence estimates by three radiographic scoring systems. Arthritis Rheum 1998;41: 361–8.
24. Solomon L, Beighton P, Lawrence JS. Rheumatic disorders in the South African Negro. Part II. Osteo-arthrosis. S Afr Med J 1975;49:1737–40.
25. Nakamura S, Ninomiya S, Nakamura T. Primary osteoarthritis of the hip joint in Japan. Clin Orthop 1989;241:190–6.
26. Yoshimura N, Campbell L, Hashimoto T, Kinoshita H, Okayasu T, Wilman C, et al. Acetabular dysplasia and hip osteoarthritis in Britain and Japan. Br J Rheumatol 1998;37:1193–7.
27. Lau EM, Lin F, Lam D, Silman A, Croft P. Hip osteoarthritis and dysplasia in Chinese men. Ann Rheum Dis 1995;54:965–9.
28. Nevitt MC, Xu L, Zhang Y, Lui LY, Yu W, Lane NE, et al. Very low prevalence of hip osteoarthritis among Chinese elderly in Beijing, China, compared with whites in the United States: the Beijing Osteoarthritis Study. Arthritis Rheum 2002;46:1773–9.
29. Chou CT, Pei L, Change DM, Lee CF, Schumacher HR, Liang MH. Prevalence of rheumatic diseases in Taiwan: a population study of urban, suburban, rural differences. J Rheumatol 1994;21:302–6.
30. Oishi CS, Hoagland FT, Gordon L, Ross PD. Total hip replacement rates are higher among Caucasians than Asians in Hawaii. Clin Orthop 1998;353:166–74.
31. Hoaglund FT, Shiba R, Newberg AH, Leung KY. Diseases of the hip: a comparative study of Japanese Oriental and American white patients. J Bone Joint Surg Am 1985;67:1376–83.
32. Cushnaghan J, Dieppe P. Study of 500 patients with limb joint osteoarthritis. I. Analysis by age, sex, and distribution of symptomatic joint sites. Ann Rheum Dis 1991;50:8–13.
33. Andersson S, Nilsson B, Hessel T, Saraste M, Noren A, Stevens-Andersson A, et al. Degenerative joint disease in ballet dancers. Clin Orthop 1989;238:233–6.
34. Eastmond CJ, Hudson A, Wright V. A radiological survey of the hips and knees in female specialist teachers of physical education. Scand J Rheumatol 1979;8:264–8.
35. Klunder KB, Rud B, Hansen J. Osteoarthritis of the hip and knee joint in retired football players. Acta Orthop Scand 1980;51:925–7.
36. Kujala UM, Kaprio J, Sarno S. Osteoarthritis of weightbearing joints of lower limbs in former elite male athletes. BMJ 1994; 308:231–4.
37. Lane NE, Hochberg MC, Pressman A, Scott JC, Nevitt MC. Recreational physical activity and the risk of osteoarthritis of the hip in elderly women. J Rheumatol 1999;26:849–54.
38. Lindberg H, Roos H, Gardsell P. Prevalence of coxarthrosis in former soccer players: 286 players compared with matched controls. Acta Orthop Scand 1993;64:165–7.
39. Marti B, Knobloch M, Tschopp A, Jucker A, Howald H. Is excessive running predictive of degenerative hip disease? Controlled study of former elite athletes. BMJ 1989;299:91–3.
40. Spector TD, Harris PA, Hart DJ, Cicuttini FM, Nandra D, Etherington J, et al. Risk of osteoarthritis associated with long-term weight-bearing sports: a radiologic survey of the hips and knees in female ex-athletes and population controls. Arthritis Rheum 1996;39:988–95.
41. Vingard E, Alfredsson L, Goldie I, Hogstedt C. Sports and osteoarthrosis of the hip: an epidemiologic study. Am J Sports Med 1993;21:195–200.
42. Puranen J, Ala-Ketola L, Peltokallio P, Saarela J. Running and primary osteoarthritis of the hip. BMJ 1975;2:424–5.
43. Panush RS, Schmidt C, Caldwell JR, Edwards NL, Longley S, Yonker R, et al. Is running associated with degenerative joint disease? JAMA 1986;255:1152–4.
44. Sohn RS, Lyle MJ. The effect of running on the pathogenesis of osteoarthritis of the hips and knees. Clin Orthop 1987;198: 106–9.
45. White JA, Wright V, Hudson AM. Relationships between habitual physical activity and osteoarthrosis in ageing women. Public Health 1993;107:459–70.
46. Axmacher B, Lindberg H. Coxarthrosis in farmers. Clin Orthop 1993;287:82–6.
47. Thelin A. Hip joint arthroses: an occupational disorder among farmers. Am J Ind Med 1990;18:339–43.
48. Croft P, Cooper C, Wickham C, Coggon D. Osteoarthritis of the hip and occupational activity. Scand J Work Environ Health 1992;18:59–63.
49. Vingard E, Alfredsson L, Goldie I, Hogstedt C. Occupation and osteoarthritis of the hip and knee: a register based cohort study. Int J Epidemiol 1991;20:1025–31.
50. Vingard E, Alfredsson L, Malchau H. Osteoarthrosis of the hip in women and its relation to physical load at work and in the home. Ann Rheum Dis 1997;56:293–8.